

AUTHORS: Bering, B. P., Dubinin, M. M., Academician, S/020/60/131/04/041/073
Zhukovskaya, Ye. G., Serpinskiy, V. V. B004/B125

TITLE: Molecular Sieves as Adsorbents¹ of the First Structural Type

PERIODICAL: Doklady Akademii nauk SSSR, 1960, Vol 131, Nr 4, pp 865 - 867 (USSR)

TEXT: The authors divide the porous adsorbents into structural types according to the size of their pores. Second structural type: silica gel with large pores and active coal with large pores. First structural type: silica gel with fine pores, active coal with fine pores, and zeolite. They tested whether zeolite belongs to the first structural type by means of the potential theory of adsorption developed in their institute. They present the equation of the adsorption isotherm (1), which establishes a linear relation between the logarithm of the adsorption a and the square of the logarithm of the relative pressure $h = p/p_g$. The isotherms of nitrogen and benzene in fine-pored silica gels (Ref 4) may be determined in a wide temperature range by determining the constants W_0 and B of the equation (1) and the affinity β of the molecular volume v and the partial pressure p_g of the saturated vapor. For the molecular sieve "Linde 5A" the experiments were carried out with nitrogen at -195° . Figure 1 shows the results of

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the experiments. The curves of the adsorption of nitrogen and argon on chabazite according to reference 6 were added for comparison. The validity of the equation (1) was tested on the basis of the determined constants by calculation of the adsorption isotherms for chloromethyl on chabazite at 0, 50, and 100°. Figure 2 shows the result. The experimental data of R. M. Barrer and D. W. Brook (Ref 9) is entered for comparison. At 50° there is good agreement between the data calculated by the authors and the experimental data from reference 9. At 100° the experimental data is somewhat lower, at 0° somewhat higher; but the deviation is at most only 5%. The authors arrive at the conclusion that the equation (1) is applicable to the study of the adsorption on zeolite and that the molecular sieves may be considered adsorbents of the first structural type. There are 2 figures and 11 references, 7 of which are Soviet.

ASSOCIATION: Institut fizicheskoy khimii Akademii nauk SSSR (Institute of
Physical Chemistry of the Academy of Sciences, USSR)

SUBMITTED: December 30, 1959

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DUBININ, M. M.

"Ways of Improving International Collaboration and the Problem of
Scientific Information"

report presented at the 10th Pugwash Conference, 2-7 Sep 61, London.

DUBININ, M. M.

"Thermal Treatment and Microporous Structure of Carbonaceous Adsorbents."

report to be submitted for the Fifth Biennial Conference on Carbon,
The Pennsylvania State University, Penna., 19-23 June 1961.

Active Mbr., Acad. Sci. USSR
Inst. of Physical Chemistry, Moscow.

S/062/61/000/001/002/016
B101/B220

AUTHORS: Dubinin, M. M., Zaverina, Ye. D., Ivanova, L. S., Kaverov,
A. T., and Kasatochkin, V. I.

TITLE: Study of the nature of the micropore structure of activated
carbons. Communication 1. Activated carbons from phenol-
aldehyde resins

PERIODICAL: Izvestiya Akademii nauk SSSR. Otdeleniye khimicheskikh nauk,
no. 1, 1961, 17-28

TEXT: The aim of the authors was to characterize the micropore structure
of activated carbons by adsorption of molecules whose dimensions are
comparable to those of the micropores. The present report deals with
activated carbons from phenyl-aldehyde resin, whose structure has been
modified considerably by treatment at various temperatures. The method of
obtaining the carbon has been described previously (Refs. 11, 12). The
product obtained by carbonization of the resin has been activated in a
rotating quartz retort at 950°C till the loss in weight amounted to about

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50%. This specimen was termed A-950. Its heating in nitrogen to 1750, 2000, and 2300°C resulted in the specimens A-1750, A-2000, A-2300. A-3000 was obtained by heating in an electric resistance furnace of the type PC-100 (RS-100). Reduction in weight was 3.21% at 1750°C, 3.50% at 2000°C, 5.53% at 2300°C, and 5.57% at 3000°C. Debye-Scherrer patterns were taken by means of a BPC-3 (VRS-3) camera; the parameters L_a and L_c of the carbon crystallites were determined according to R. E. Warren (Ref. 13) and the radiographic density q was calculated from equation $q = zAm/abc$ ($Z=4$, number of C atoms in the unit cell; $A=12$, atomic weight of C; $m=1.66 \cdot 10^{-24}$ g, mass of the H atom; $a=b=2.456$ Å, constants of the graphite crystal lattice in the basal surface; $c=2d_{002}$, dimension of the unit cell along axis c). Table 1 indicates the data obtained. The adsorption properties of the specimens were determined in a wide range of relative pressure by means of a sorption balance for benzene, cyclohexane, and water at 20°C (Table 2). The constants of the isothermal lines of adsorption were calculated from Eq. (4) of the potential theory of adsorption: $a = a'_0 \exp \left[(-B(T^2/\beta^2)(\log p_s/p)^2) \right]$, where $a'_0 = W_0/v$ (5)

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Study of the nature of the micropore...

corresponds to the maximum occupation of the adsorption volume W_0 and v is the volume of 1 millimole of the adsorbed substance (Table 3). This carbon has a mixed structural type with two kinds of micropores as shown in Fig. 5 for benzene and A-1750. In the micropores of the first type, which correspond to a'_0 , there occurs an increase of the adsorption potential. This effect is absent in large micropores of the second type (a''_0). The following relation has been obtained: $a'_0 + a''_0 = a^0$ (6).

a^0 is the adsorption occurring at the beginning of hysteresis and capillary condensation of the vapor in the intermediate pores. This value is represented in Fig. 5 by a broken vertical line: $(p/p_s)_0 = 0.175$. Based on the sorption isotherm, the volumes of the different types of pores were evaluated: $v_{m1} = v'_{m1} + v''_{m1}$ are the volumes of the two types of micropores;

v_1 is the volume of the intermediate pores; and v_g is the total volume of pores (Table 4). Tables 6 and 7 indicate the values found for the adsorption of organic substances and electrolytes. The crystallite surfaces (cylindrical lateral surface S_l , basal surfaces S_b) which were obtained from radiographical data do not coincide with calculations

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according to Brunauer, Emmett and Teller, and Langmuir (Table 8). An attempt has been made to explain the structure by the example of A-950. It is assumed that binary micropores are formed by the combustion of two superposed crystallites when the carbon is heated. α is assumed to be the specific surface of the micropores composed of the surface α of the single micropores and of $1-\alpha$ of the "binary" ones. In the single micropores, n_1 molecules of one vapor and n_2 molecules of another vapor are assumed to be adsorbed. Correspondingly, n_1'' , n_2'' molecules are adsorbed in the binary pores. ω_1 , ω_2 are assumed to be the areas occupied by the adsorbed molecules. The following relations have been obtained:

$$\alpha n_1 / 2\omega_1 + (1-\alpha) n_1'' / 2\omega_1 = a_0' \quad (11) \text{ and } \alpha n_2 / 2\omega_2 + (1-\alpha) n_2'' / 2\omega_2 = a_0'' \quad (12)$$

$$\text{resulting in } \alpha = (An_2'' - n_1'') / [(An_2'' - n_1'') - (An_2' - n_1')] \quad (13), \text{ where}$$

$$A = a_0' \omega_1 / a_0'' \omega_2 \quad (14) \text{ and } s = 2a_0' \omega_1 / [\alpha n_1' + (1-\alpha) n_1''] \quad (15). \text{ For A-950}$$

one obtains $\alpha = 0.256$ and $s = 568 \text{ m}^2/\text{g}$. Thus, binary pores are formed for the major part (74%). This approximative model of micropores agrees with radiographic data and reproduces the measurements of adsorption correctly. D. N. Strazhesko, S. G. Tolkachev, and I. V. Uspenskiy are thanked for

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Study of the nature of the micropore...

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assistance. There are 5 figures, 8 tables, and 25 references: 15 Soviet-bloc and 9 non-Soviet-bloc.

ASSOCIATION: Institut fizicheskoy khimii Akademii nauk SSSR (Institute of Physical Chemistry, Academy of Sciences USSR). Institut goryuchikh iskopayemykh Akademii nauk SSSR (Institute of Mineral Fuels, Academy of Sciences USSR). Institut fizicheskoy khimii Akademii nauk USSR (Institute of Physical Chemistry, Academy of Sciences UkrSSR)

SUBMITTED: October 13, 1959

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S/062/61/000/001/003/016
B101/B220

AUTHORS: Dubinin, M. M., Zaverina, Ye. D., Kaverov, A. T., and
Kasatochkin, V. I.

TITLE: Nature of the micropore structure of activated carbons.
Communication 2. Activated carbons from polyvinylidene
chloride

PERIODICAL: Izvestiya Akademii nauk SSSR. Otdeleniye khimicheskikh nauk,
no. 1, 1961, 29-37

TEXT: The aim of the authors was to study the modification of the micropore structure of activated carbons brought about by physical, physicochemical, and chemical effects. The present report deals with the effect of thermal treatment on activated carbon produced from polyvinylidene chloride. The micropore structure of this carbon is not the result of the combustion of large amounts of carbon, but of the release of hydrochloric acid. Regarding the production of the carbon, Refs. 2,3 are referred to. Additional activation by CO₂ up to a loss in weight of about

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10% was effected at 750°C. This specimen was termed B-750. Further thermal treatment resulted - corresponding to the temperature - in the specimens B-1300 (loss in weight 0.38%), B-1750 (loss in weight 4.00%), B-2300 (loss in weight 5.35%), and B-3000 (loss in weight 7.17%). Like in Ref. 1, the structure of the carbon crystallites was studied by means of X-rays, and L_c , L_a , d_{002} , and the radiographic density q were determined (Table 1). Moreover, the isothermal lines of adsorption at 20°C were determined for benzene (Fig. 2) and cyclohexane (Fig. 3). Prior to the adsorption, the carbon was evacuated at 450°C and about 1.10^{-6} mm Hg. The substantially reduced adsorption of cyclohexane is attributed to the more complex structure of its molecules. The structural characteristics are indicated in Table 2. a_{mi} is the adsorption corresponding to the complete filling of the micropores. In the case of benzene, it occurs at a relative pressure $p/p_s = 0.175$, and in the case of cyclohexane, at $p/p_s = 0.158$: a_s denotes the total adsorption at $p/p_s = 1$, v_s the total volume of pores, v_{mi} the volume of the micropores, and v_i that of the intermediate pores calculated from the difference. The experimental isothermal lines were compared with the equation of the potential theory of adsorption:

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$a = (W_0/v) \exp \left[(-B(T^2/\beta^2)(\log p_s/p)^2) \right] (1)$. W_0 is the maximum adsorption volume, B a constant dependent on the size of the micropores, and β the affinity coefficient. The data calculated from (1) are indicated in Table 3. It was found (Fig. 5) that at a high relative pressure, the experimental data are lower than those obtained from Eq. (1). It is assumed that the reason is either ultraporosity or non-equilibrium. Referring to a paper of R. Franklin (Ref. 7), the structure of polyvinylidene chloride carbon is explained. The micropores are slit-shaped interstices between the crystallites or individual plane graphite lattices. They give room to hardly more than 2-3 layers of adsorbed molecules. On the assumption of $41 \text{ \AA}^2$ occupied area for one benzene molecule and of $38 \text{ \AA}^2$ occupied area for one cyclohexane molecule, a comparison between the specific surfaces calculated by X-ray analysis, sorption, and a bidisperse model (Table 4) results in the usability of a bidisperse model; the final clarification of the character of porosity is reserved for further investigations. The difference observed in specimen B-1750 regarding the adsorption of benzene and cyclohexane is attributed to a molecular

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screening effect. This is shown by comparison with a Linde MC-5A screen. S. G. Tolkachev and I. V. Uspenskiy are thanked for assistance. There are 5 figures, 5 tables, and 10 references: 7 Soviet-bloc and 3 non-Soviet-bloc.

ASSOCIATION: Institut fizicheskoy khimii Akademii nauk SSSR (Institute of Physical Chemistry, Academy of Sciences USSR); Institut goryuchikh iskopayemykh Akademii nauk SSSR (Institute of Mineral Fuels, Academy of Sciences USSR)

SUBMITTED: December 26, 1959

Card 4/4

DUBININ, M.M.; ZAVERINA, Ye.D.

Nature of the microporous structure of activated charcoals. Report
No.3: Activated charcoals obtained from various carbonized materials.
Izv. AN SSSR. Otd. khim. nauk no.2:201-204 F '61. (MIRA 14:2)

1. Institut fizicheskoy khimii AN SSSR.
(Charcoal)

KADLETS, O.; DUBININ, M.M.

Kinetics of the thermal degradation of solid substances. Report No.2:
Thermal degradation of silver carbonate. Izv.AN SSSR Otd.khim.nauk
no.3:390-396 Mr '61. (MIRA 14:4)

1. Institut fizicheskoy khimii Chekhoslovatskoy Akademii nauk,
Praga.

(Silver carbonate)

S/062/61/000/003/002/013
B117/B208

AUTHORS: Dubinin, M. M., Vishnyakova, M. M., Zaverina, Ye. D.,
Zhukovskaya, Ye. G., Leont'yev, Ye. A., Luk'yanovich, V. M.,
and Sarakhov, A. I.

TITLE: Study of adsorption properties and structure of secondary
pores of adsorbents having the effect of molecular sieves.
Report 1. Industrial samples of synthetic zeolites

PERIODICAL: Izvestiya Akademii nauk SSSR. Otdeleniye khimicheskikh
nauk, no. 3, 1961, 396-406

TEXT: The authors studied some peculiarities of the adsorption properties
of typical industrial samples of synthetic zeolites and the structure of
their secondary pores. They used industrial samples from molecular sieves
designed by Linde 4A (designated by MC-4A(MS-4A)), and 5A (designated by
MC-5A (MS-5A)) in the form of 4-8 mm long grains with an average diameter
of ~3.2 mm. Sorption isotherms and, in some cases, desorption isotherms
of nitrogen vapors at -195°C, and water, benzene, and cyclohexane vapors
at 20°C were determined. A similar apparatus as that described in Ref. 2

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Study of adsorption properties...

(B. P. Bering, M. M. Dubinin, Ye. G. Zhukovskaya, A. I. Sarakhov, and V. V. Serpinskiy, Zh. fiz. khimii 31, 712, 1957) was applied. To study the structure of secondary pores of MS-4A and MS-5A grains, low- and high-pressure porosimeters were used. The latter was a redesigned device of the ПA-4 (PA-4) type (Ref. 5: T. G. Plachenov, V. A. Aleksandrov, and G. M. Belotserkovskiy, Metody issledovaniya struktury vysoko-dispersnykh i pcristykh tel, Izd. AN SSSR, M., 1953, str. 59). For the electron-microscopic examination of the structure of secondary pores, the method of single-stage carbon replicas was used. The pictures of carbon replicas of MS-4A and MS-5A taken by means of an V3M-100 (UEM-100) electron microscope showed no marked differences. A thorough analysis of stereophotographs indicates that there was no dense packing of the zeolite crystals in the grains. There are interstices of the order of magnitude of small crystals, i.e., some tenths of a micron or some thousandths of an angstrom. Strong enlargements show that the crystal surface is not amorphous. The studies of MS-4A and MS-5A disclosed that the potential adsorption theory could be applied to them. As the authors had not obtained any experimental data, they used the results obtained by N. V. Kel'tsev, for water vapor at 20° and 80°C and at equilibrium pressures p = 1 and 25 mm Hg, which had been

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Study of adsorption properties...

made available to them. The measured values of adsorption deviate from the calculated values by 3 % at most. Eq. (1) expresses the temperature dependence of the adsorption isotherms satisfactorily:

$$(1) \quad a = (W_0/v) \exp \left[-B \frac{T^2}{\beta^2} (\log p_g/p)^2 \right]$$

W_0 = limiting volume of the adsorption space, which is equal to the volume of the micropores of the adsorbent; B = constant dependent on the dimensions of the micropores, which determine the increase of the adsorption potentials; β = affinity factor of the characteristic lines; v = volume of 1 mm of the vapor liquefied at the experimental temperature T . When considering the structure of the secondary pores, it was found that it may be quantitatively described by the sorption and mercury methods of measuring the pores. The characteristics obtained for the pore structure of MS-4A and MS-5A are given in Table 4. There are 9 figures, 7 tables, and 13 references: 12 Soviet-bloc and 1 non-Soviet-bloc.

ASSOCIATION: Institut fizicheskoy khimii Akademii nauk SSSR (Institute of Physical Chemistry, Academy of Sciences USSR)

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Study of adsorption properties...

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SUBMITTED: December 30, 1959

Legend to Table 4: Porosity of grains from Linde's molecular sieve;
1) adsorbent; V_2 = volume of secondary pores; $V_{\Sigma} = V_1 + V_2$

Adsorbent ①	$W_0, \text{cm}^3/\text{s}$ N_2	$W_0, \text{cm}^3/\text{s}$ H_2O	$V_1 = \bar{W}_0, \text{cm}^3/\text{s}$	$V_2, \text{cm}^3/\text{s}$	$V_{\Sigma}, \text{cm}^3/\text{s}$
MC-4A	—	0,233	0,233	0,302	0,535
MC-5A	0,219	0,202	0,210	0,323	0,533

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DUBININ, M.N.

Nature of the microporous structure of active carbons. Report No.4:
Development of the micropore volume in the process of coal activation.
Izv.AN SSSR.Otd.khim.nauk no.5:750-756 My '61. (MIRA 14:5)

1. Institut fizicheskoy khimii AN SSSR.
(Carbon, Activated)

SARAKHOV, A.I.; DUBININ, M.M.; BEREZKINA, Yu.F.; ZAVERINA, Ye.D.

Vapor adsorption on model nonporous sorbents with physically modified surface. Report 1: Low temperature adsorption of nitrogen vapors on carbon black with preadsorbed water. Izv.AN SSSR, Otd. khim.nauk no.6:974-983 Je '61. (MIRA 14:6)

1. Institut fizicheskoy khimii AN SSSR.
(Nitrogen) (Adsorption)

S/064/61/000/007/003/005
B124/B206

AUTHORS: Agafonov, A. V., Dubinin, M. M., Onusaytis, B. A.,
Torocheshnikov, N. S.

TITLE: Studies on production and application of new selective
adsorbents - molecular sieves - in the USSR

PERIODICAL: Khimicheskaya promyshlennost', no. 7, 1961, 26 - 30

TEXT: The authors give a short summary of the main results of studies in the field of synthetic zeolites conducted in various scientific institutes in 1960 on the basis of the coordination plan of the Komissiya po tseolitam (Zeolite Commission). The Zeolite Commission under the chairmanship of Academician M. M. Dubinin was established at the Otdeleniye khimicheskikh nauk AN SSSR (Department of Chemical Sciences, AS USSR) in 1959, in order to coordinate studies in the field of synthesis and application of synthetic zeolites. Its activities comprised: 1) development of synthesis- and technological processes for synthetic zeolites; 2) investigation of structural properties and adsorption of synthetic and natural zeolites, and 3) study of the application of synthetic zeolites for the drying and separation of gases. Crystallization of zeolites and their ion exchange prop-
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Studies on production...

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erties were investigated at the Institut fizicheskoy khimii AN USSR (Institute of Physical Chemistry, AS USSR) under the direction of I. Ye. Neymark, zeolites of the types CaA, KA, LiA, BeA etc having been produced (the authors use the designations NaA, CaA, NaX and CaX, approved by the above-mentioned Commission, instead of the customary designations 4A, 5A, 10X and 13X). One of the institutes of the chemical industry under the direction of G. I. Mikulin and V. Ya. Nikolenko investigated the technological conditions for the synthesis of zeolites, and one of the institutes of the petroleum industry under the direction of Ya. V. Mirskiy the conditions for the production of crystalline zeolites of the type NaA and CaA in the laboratory and pilot plant. Optimum conditions for the synthesis of zeolites of the types NaA and NaX, as well as the ion exchange for the production of the CaA and CaX zeolites were studied in the laboratory under the direction of M. S. Misin and L. M. Maksimova. The conditions for the synthesis of zeolites of the types A and X were studied at the institut neftyanoy promyshlennosti (Institute of the Petroleum Industry) under the direction of A. V. Agafonov, L. I. Piguzova and B. A. Lipkind, applying the process used by N. S. Kurnakov (Ref. 3: Izv. AN SSSR, 6, 1381, (1937)) for the production of Permutit. The use of aluminum sulfate and aluminum oxy-

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chloride in the synthesis of zeolites was studied in a laboratory of the chemical industry under the direction of V. S. Vinogradova and L. S. Kofman. The institut khimii AN Gruz. SSR (Institute of Chemistry of the Georgian SSR) under the direction of G. V. Tsitsishvili dealt with the kinetics of the crystallization of the NaA zeolites, and the Institut khimii silikatov AN SSSR (Institute of Silicate Chemistry, AS USSR) under the direction of S. P. Zhdanov with the optimum conditions for the production of Na zeolites by hydrothermal synthesis in the temperature range of from 70 to 200°C from strongly basic aluminum silica gels with a base excess of 300 - 500%. The studies by the laboratoriya GEOKhI AN SSSR (Laboratory of the GEOKhI, AS USSR) under the direction of N. I. Khitarov dealt with the drying of gases by means of the natural zeolites natrolite, desmine, thomsonite and limonite, while the use of the chemical-catalytical method for the production of natrolite granules was tried out at the IGI AN SSSR (IGI, AS USSR) under the direction of B. A. Onusavtis. D. P. Dobyichin elaborated a process for the production of porous glasses of the molecular sieve type yielding a molecular sieve with a porosity close to that of the CaA zeolite from the Na-7/23 (Na-7/23) glass, and one with a porosity similar to that of the NaX zeolite from the Na-10/30

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Studies on production...

(Na-10/30) glass. A number of investigations of the structure and adsorption of synthetic and natural zeolites was conducted at the Institute of Physical Chemistry, AS USSR under the direction of M. M. Dubinin. The distribution curves of the zeolite crystals were determined by the electron microscope investigation conducted by V. M. Luk'yanovich.

D. P. Timofeyev studied the kinetics of steam adsorption, A. V. Kiselev the adsorption of nitrogen, benzene vapors and hexane on the molecular sieves NaA and CaX as well as the adsorption of benzene and n-hexane and their mixtures on the molecular sieve CaA. X-ray photographic investigations were made under the direction of N. A. Shishakov. Studies conducted under the direction of I. Ye. Neymark at the Institute of Physical Chemistry, AS USSR showed that the equilibrium adsorption on zeolites is well described by the potential theory, and that the thermal stability of zeolites drops in the sequence $CaA > KA > NaA > NH_4A$. The properties of Soviet and American molecular sieves during drying of gases were compared at the Leningradskiy tekhnologicheskii institut im. Lensovet (Leningrad Technological Institute imeni Lensovet) under the direction of T. G. Plachenov and G. M. Belotserkovskiy. Studies on the drying and purification of gases by means of molecular sieves were conducted at the Moskovskiy khimiko-

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BA DUBININ, M.M.

Affinity coefficients for carbons of the second structure type. M. M. Dubinin, M. D. Zaverian, and D. P. Timofeev. *Doklady Akad. Nauk S.S.S.R.* 77, 821 (1961). Adsorption isotherms of vapors of C_{10}H_8 , PhMe , C_{10}H_6 , EtCl , and MeOH , at 20° , were detd. on 3 samples of coarse-pore (2nd-type) carbons, (I) activated by impregnation with ZnCl_2 , (II) activated by CO_2 at 950° to a wt. of 80%, (III) nonporous lampblack with spherical particles. The values of w_s (cc./g.) and $10^4 A$ in the adsorption equation $s = (w_s/v) \exp[-A T \log(p_s/p)]$ are: (I) 1.210 and 2.34; (II) $1 \times 10^{-3} - 0.80$, (II) 1.140 and 2.12 ($1 \times 10^{-3} - 0.25$), (III) 0.089 and 3.63 (0.01-0.80). Curves of the adsorption potential $s = RT \ln(p_s/p)$ as a function of the surface coverage $w = w_s$ (s = amt. adsorbed, v = mol. vol.) for all 3 substances on each adsorbent show satisfactory affinity. The affinity coeffs. $\beta = s/w$ relative to C_{10}H_8 ($w = 1$), on carbons I, II, III, compared with β on fine-pore carbons of the 1st structure type (C.A. 43, 167), are: C_{10}H_8 1.50, 1.49, 1.70, and 1.59; PhMe 1.16, 1.27, —, and 1.25; C_{10}H_6 1; EtCl 0.70, 0.77, 0.78, and 0.76; MeOH 0.35, 0.39, 0.41, and 0.40. Consequently, for each given substance, β is practically the same on carbons of the 1st and of the 2nd structure type. N. Tim

1951

DUBININ, M.M., akademik, otvetstvennyy redaktor; GAPON, Ye.N.; GAPON, T.B.;
ZHYPARHINA, Ye.S.; RACHINSKIY, V.V.; BELEN'KAYA, I.M.; SHUVAEVA, G.M.;
ROGINSKIY, S.Z.; YANOVSKIY, N.I.; FUES, N.A.; KISELEV, A.V.; HEYMARK, I.Ye.;
SLINYAKOVA, I.B.; KHATSET, F.I.; LOSEV, I.P.; TROSTYANSKAYA, Ye.B.;
TEVLINA, A.S.; DAVANKOV, A.B.; SALDADZE, K.M.; BRUMBERG, Ye.M.; ZHIDEKOVA,
Z.V.; VEDENEVA, N.Ye.; NAPOL'SKIY, S.A.; MIKHAYLOVA, Ye.A.; KAZANSKIY, B.A.;
RYABCHIKOV, D.I.; SHEMAKIN, F.M.; KRETOVICH, V.L.; BUNDEL', A.A.; SAVINOV,
B.G.; VENDT, V.P.; EPSHTEYN, Ye.A.

[Research in the field of chromatography transactions of the All-Union
Conference on Chromatography, November 21-24, 1950] Issledovaniia v oblasti
khromatografii; trudy Vsesoiuznogo soveshchaniia po khromatografii, 21-24
noiabria 1950 g. Moskva, Izd-vo Akademii nauk SSSR, 1952. 225 p.

(MLRA 6:5)

1. Akademiya nauk SSSR. Otdelenie khimicheskikh nauk.

(Chromatographic analysis)

Card I

DUBININ, M. M.

Structure of active carbons and their adsorptive properties. N. N. Avgul, Q. M. Dzhibit, M. M. Dubinin, and A. V. Kiselev (State Univ.). Doklady Akad. Nauk S.S.S.R. 79, 451--4 (1951).--The early stages of sorption of org. vapors by active C is pure adsorption, whereas later stages, involve simultaneous adsorption and capillary condensation; at the latter stage, the sorption and desorption do not coincide (hysteresis). The ratio of adsorption and capillary condensation for a given adsorbable vapor, depends on the pore structure type of the active C. From adsorption isotherms of H₂O (at 25°), MeOH, C₆H₆, C₇H₁₆, and BuOH vapors (at 20°), on (I) a fine-pore C prep'd. by activation of sucrose C with CO₂ at 1000° until a loss of wt. of 45%, (II) coarse C from sucrose, activated with a 5-fold excess of ZnCl₂, heat-treated at 650° and washed, it can be concluded that in I the org. mols, fill the whole pore vol. already available to adsorption during the 1st stage. There is no capillary condensation of the smaller H₂O mols. is due to capillary condensation in the micropores. In II capillary condensation is responsible for the major part of the adsorption of the org. vapors also. The vols. of substance adsorbed in the form of liquid of normal d., at the beginning of the hysteresis (Vh) and at satn. p/p = 1 (Vs), for C₆H₆, C₇H₁₆, BuOH, MeOH, H₂O, are, on I, ---and 0.60, --- and 0.59, --- 0.55, ---and 0.63, 0.07 and 0.51; on II, 0.92 and 2.34, 1.34 and 2.36, ---and 1.09 and 2.21, 0.03 and 2.01. In accord with the pore-structure types of I and II, the adsorption isotherms of I are representable by $a = (w_0/vm) \exp (-B(T^2/B^2) \log (p/p^*))$ with the values (for C₆H₆, C₇H₁₆, BuOH, MeOH) $w_0 = 0.59$,

0.55, 0.54, 0.61 cc/g., $10^6 B/B^2 = 1.00, 0.143, 1.01, 0.76, B = 1.00$ (by convention),
 1.53, 0.99, 0.36, and the isotherms on II by $a = (w_0'/V_m) \exp(-A(T/P) \log$
 $(P_3/P))$, with $w_0' = 1.50, 1.60, -, 1.85$ cc./g., $10^3 A/B = 2.23, 1.93, -, 8.52$
 $B = 1.00, 1.47, -, 0.33$. For I the values of the vol. of the adsorption space,
 w_0 , are very close to v_g , which indicates near-absence of intermediate pores.
 The applicability of the 2 isotherm equations to I and II, resp., is borne out
 by the identity of the B values (affinity coeffs.) for each substance in the
 2 instances.
 N. Thon.

DUBININ, M. M.

Jul/Aug 52

USSR/Chemistry - Adsorbents

"The Pore Structure of Adsorbents," M. M. Dubinin, Inst of Phys Chem, Acad Sci USSR

"Iz Ak Nauk SSSR, Otdel Khim Nauk" No 4, pp 577-582

States that the type of porosity (distribution of pore sizes) can be detd from differential curves constructed on the basis of desorption isotherms for water vapor, because water fills pores due to capillary condensation only. Such measurements show that activated carbon has 3 definite sizes of pores (is tridisperse): its

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differential curve has 3 maxima. Notes that silica gels are adsorbents of the monodisperse type, but often show considerable dispersion of pore sizes. They practically lack macropores: the pores are either of the micro type of intermediate, article states. Bidisperse porous glasses have been obtained. The radii of micropores of carbons lie between 11-25 A, those of intermediate pores between 70-170A. Author states that in USSR publications, classification of pores as macro, micro, or intermediate corresponds to quant data on pore sizes: it is not merely qual.

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DUBININ, M. M.

USSR/Chemistry - Adsorption

Sep/Oct 52

"Adsorption of Gases and Vapors and the Structure of Adsorbents (7th Mendeleev Lecture, Leningrad, 7 February 1952)," M. M. Dubinin, Moscow

"Uspekhi Khim" Vol XXI, No 5, pp 513-533

Reviews the work done by himself and collaborators on this subject during recent years.

214726

DUBININ, M. M.

Congress of the Hungarian Chemists. Priroda 41, No 1, 1952.

1 May 52

USSR/Chemistry - Adsorption

"Ways of Controlling the Structure of Activated Carbons Made From Sucrose," Acad M. M. Dubinin, Ye. D. Zaverina

"Dok Ak Nauk SSSR" Vol LXXXIV, No 1, pp 93-96

Carbon made from sucrose is practically ash free and hence has high adsorptive qualities. Sucrose was dissolved together with an inorg salt (zinc chloride and other salts of varying solubility) and the soln evapd to dryness. The residue was charred in a porcelain crucible at 800° and the carbon carefully washed to neg chloride ion test (in the case of Zn Cl₂). Adsorption isotherms at 20° were detd for samples

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prepd in this manner. Addn of the salt results in higher surface area and greater adsorption. Three types of isotherms were obtained corresponding to variations in pore size: sucrose alone; sucrose + 2 a Cl₂; sucrose + Na Cl.

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DUBININ, M.M.

USSR/Chemistry - Adsorption May 52

"The Pore Structure of Activated Carbons,"
V. A. Aleksandrov, Acad M. M. Dubinin, Ye. D.
Zaverina, T. G. Plachenov, S. G. Chepurnoy

"Dok Ak Nauk SSSR" Vol 84, No 2, pp 301-304

Article states that the macroporous variety of activated charcoals has a pore radius of 1×10^{-5} to 1×10^{-4} cm and a specific surface of $1 - 2 \text{ m}^2/\text{g}$. Therefore, these pores act as main arteries for the movement of adsorbed mols. Finer pores are transitional, being filled during sorption of

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org vapors by the process of capillary condensation. A still finer variety of pores in activated charcoal is the microporous. These pores are almost the size of mols and the specific surface is of the order of several hundred sq m/g .

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ACAD M. M. DUBININ

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DUBININ M. M. (ACAD)

USSR/Chemistry - Adsorption

21 May 52

"The Effect of the Pore Structure of Adsorbents on
the Shape of the Adsorption Isotherm of Vapors,"
Acad M. M. Dubinin

"Dok Ak Nauk SSSR" Vol LXXXIV, No 3, pp 539-542

Summarizes former work done by himself and his associates on the subject and formulates general relationships as well as their specific applications to adsorbents of different chem types (polar substances, e.g., quartz, silica gel, alumina-silica gels as compared with nonpolar substances, e.g., carbon), adsorbents of the same type having different pore sizes, and adsorbed substances which are polar (e.g., methyl alc) or nonpolar (e.g., n-heptane).

225T10

DUBININ, M.M., akademik, otvetstvennyy redaktor; KISELEV, A.V., professor, redaktor; LUK'YANOVICH, V.M., kandidat khimicheskikh nauk, redaktor.

[Methods of studying the structure of highly dispersed and porous bodies; transactions of the conference of June 25-29, 1951] Metody issledovaniia struktury vysokodispersnykh i poristykh tel; trudy soveshchaniia 25-29 iunია 1951 g. Moskva, Izd-vo Akademii nauk SSSR, 1953. 163 p. (MLRA 7:4)

1. Akademiya nauk SSSR, Otdeleniye khimicheskikh nauk.
(Porosity) (Adsorption)

DUBININ, M. M.

DUBININ, M.M.

[Reports at the 13th International Congress of Theoretical and Applied Chemistry; Stockholm, 1953] Deklady na XIII Mezhdunarodnom kongresse teoreticheskoi i prikladnoi khimii; Stekkel'm, 1953. Moskva, Izd-vo Akademii nauk SSSR, 1953. 350 p. (MLBA 7:5)

1. Congrès international de chimie pure et appliquée.
(Chemistry--Congresses)

DUBININ, M. M.

"Adsorbtsiya Gazov I Parov I Struktura Adsorbentov,"

XIIIth International Congress of Pure and Applied Chemistry, XVIth Conference
of the Union (IUPAC) Stockholm, Jul 29 - Aug 4, 1953 Uppsala August 5-7 1953

T T A L P I J N E T , D O M A I N N A M E : V U U R S A C H . N E T ; G E N E R A L I Z E R ; F I L E S ; W E B S I T E S

Volumetric-chromatographic method for gas analysis. Dokl. AN SSSR 90 no. 4: 577-579 Jo '53. (MLRA 6:5)

1. Akademiya Nauk SSSR (for Dubinin). 2. Nauchno-issledovatel'skiy institut khimii pri Gor'kovskom gosudarstvennom universitete (for Vyakhirev, Bruk, Guglina). (Gases--Analysis)

NIKITIN, I.G.; DUBININ, F.F.; MAGGOSHIN

Sorptive properties of baked calcium and magnesium oxides. Dokl. AN SSSR
90 no.4:591-594 Je '53. (MLBA 6:5)

1. Akademiya nauk SSSR (for Dubinin). 2. Institut khimii silikatov Aka-
demii nauk SSSR (for Nikitin). (Oxides)

KHAKIN, A.N.; KROIZOV, F.N.; VOLIN, A.F.; KROIZOV, F.N.; KROIZOV, F.N.; KROIZOV, F.N.

Chromato-thermographic separation of dissolved substances. Dokl. AN SSSR
90 no.4:611-614 Je '53. (MLRA 6:5)

1. Akademiya Nauk SSSR (for Dubinin). (Chromatographic analysis)

BERING, B.P.; SERPINSKIY, V.V.; DUBININ, M.M., akademik.

Volumetric-gravimetric method for measuring the adsorption of gaseous mix-
tures. Dokl. AN SSSR 90 no.5:811-814 Je '53. (MLRA 6:5)

1. Institut fizicheskoy khimii Akademii nauk SSSR (for Bering, Serpinskiy).
2. Akademiya nauk SSSR (for Dubinin). (Gases) (Adsorption)

DUBININ, M.M., akademik; LUK'YANOVICH, V.M.; RADUSHKEVICH, L.V.

Electron-microscopic investigation of the form of transitional pores in
activated carbons obtained from sugar. Dokl. AN SSSR 91 no.3:585-587 J1
'53. (MLBA 6:7)

1. Institut fizicheskoy khimii Akademii nauk SSSR (for Luk'yanovich and Radushkevich).
 2. Akademiya nauk SSSR (for Dubinin).
- (Carbon, Activated) (Electron microscope)

AVGUL', N.M.; DZHIGIT, O.M.; KISELEV, A.V.; SHCHERBAKOVA, K.D.; DUBININ, M.M.,
akdemik.

Isotherm and heat of adsorption of water vapors on carbon black. Dokl.AN
SSSR 92 no.1:105-108 S '53. (MIRA 6:8)

1. Akademiya nauk SSSR (for Dubinin). 2. Institut fizicheskoy khimii Akademii
nauk SSSR (for Avgul', Dzhigit, Kiselev and Shcherbakova). 3. Moskovskiy gos-
darsvennyy universitet im. M.V.Lomonosova (for Avgul', Dzhigit, Kiselev and
Shcherbakova). (Adsorption) (Water) (Carbon black)

BORESKOV, G.K.; SLIN'KO, M.G.; VOLKOVA, Ye.I.; DUBININ, M.M., akademik.

Catalytic activeness of metals and platinum-gold alloys in relation to the oxidation of sulfur dioxide. Dokl.AN SSSR 92 no.1:109-110 S '53.

(MLRA 6:8)

1. Akademiya nauk SSSR (for Dubinin).

(Catalysts) (Oxidation) (Sulfur dioxide)

DUBININ, M.M., akademik; ZAVERINA, Ye.D.

Sorption of water vapors by active carbons. Dokl. AN SSSR 92 no.1:111-114
S '53. (MLBA 6:8)

1. Akademiya nauk SSSR (for Dubinin). (Sorption) (Water)
(Carbon, Activated)

VYSOTSKIY, Z.Z.; HEYMARK, I.Ye.; ~~DUBININ, M.M.~~, akademik.

Effect of the hydrophobic component of mixed sorbents, on the mechanism of formation of their porous structure. Dokl.AN SSSR 92 no.2:357-359 S '53.
(MIRA 6:9)

1. Akademiya nauk SSSR (for Dubinin). 2. Institut fizicheskoy khimii im. K.V.Pisarshevskogo Akademii nauk Ukrainakoy SSR (for Vysotskiy and Heymark).
(Sorbents)

KARNAUKHOV, A.P.; KISELEV, A.V.; KHRAPOVA, Ye.V.; DUBININ, M.M., akademik.

Adsorption of nitrogen vapors on carbon black. Dokl.AN SSSR 92 no.2:361-364
S '53. (MLRA 6:9)

1. Akademiya nauk SSSR (for Dubinin). 2. Moskovskiy gosudarstvennyy universitet
im. M.V.Lomonosova (for Karaukhov, Kiselev and Khrapova).
(Carbon black) (Adsorption) (Nitrogen)

NIKITIN, Ye.N.; DUBININ, M.M., akademik.

Sorptive properties of sintered equimolecular mixtures $\text{CaO} - \text{ZrO}_2$ and $\text{MgO} - \text{ZrO}_2$. Dokl. AN SSSR 92 no.3:617-620 S '53. (MLBA 6:9)

1. Akademiya nauk SSSR (for Dubinin).
2. Institut khimii silikatoov Akade-
mii nauk SSSR (for Nikitin). (Sorption) (Solutions, Solid)

TSITSISHVILI, G.V.; BARNABISHVILI, D.I.; DUBININ, M.M., akademik.

Effect of acid treatment on the properties of bleaching clays. Dokl. AN SSSR
92 no.3:633-635 S '53. (MLRA 6:9)

1. Akademiya nauk SSSR (for Dubinin). 2. Institut khimii im. P.G. Melikish-
vili Akademii nauk Gruzinskoy SSR (for Tsitsishvili and Barnabishvili).
(Sorbents)

AVGUL', N.N.; DZHIGIT, O.M.; KISELEV, A.V.; SHCHERBAKOVA, K.D.; DUBININ, M.M.,
akademiik.

Isotherm of the heat of the adsorption of methyl alcohol on carbon black.
Dokl.AN SSSR 92 no.6:1185-1188 0 '53. (MLRA 6:10)

1. Akademiya nauk SSSR (for Dubinin). 2. Moskovskiy gosudarstvennyy universi-
tet im. M.V.Lomonosova, Institut fizicheskoy khimii Akademii nauk SSSR (for
Avgul', Dzhigit, Kiselev and Shcherbakova).

(Methyl alcohol) (Adsorption)

BERING, B.P.; IOYLEVA, K.A.; DUBININ, M.M., akademik.

Vapor adsorption on the surface of mercury. Dokl.AN SSSR 93 no.1:85-88 N '53.
(MLRA 6:10)

1. Akademiya nauk SSSR (for Dubinin). 2. Institut fizicheskoy khimii Akademii nauk SSSR i Moskovskiy gosudarstvennyy universitet in. M.V.Lomonosova (for Bering and Ioyleva).
(Mercury) (Adsorption)

KISELEV, A.V.; KULICHENKO, V.V.; DUBININ, M.M., akademik.

Adsorption of triethylamine from vapors and solutions to various structure silica gel. Dokl. AN SSSR 93 no.1:101-104 N '53. (MLRA 6:10)

1. Akademiya nauk SSSR (for Dubinin). 2. Moskovskiy gosudarstvennyy universitet im. V.V. Lomonosova (for Kiselev and Kulichenko).
(Adsorption) (Triethylamine) (Silica gel)

DUBININ, M. M. (Acad.)

"Put Chemistry at Service of Technical Progress," Pravda, p.2, 11 Nov 55.

Translation - Current Digest of Sov. Press, Vol.7, No.45, page 26, 21 Dec 55

DUBININ, M.M.

Introduction. Izv.Sekt.plat. i blag.net. no.28:9-10 '54.(MLBA 7:9)

1. Akademik-sekretar' otdeleniya khimicheskikh nauk Akademii nauk SSSR.
(Compounds, Complex) (Platinum)

USSR/ Physics - Physical chemistry

Card 1/1 Pub. 22 - 39/63

Authors : Dubinin, A.M., Academician; and Serpinskiy, V.V.

Title : Equation of isotherm of water vapor adsorption on active carbons

Periodical : Dok. AN SSSR 99/6, 1033-1036, Dec 21, 1954

Abstract : In order to learn more about the sorption nature of water vapors on active carbons the authors investigated the isotherm adsorption of water vapor on non-porous and porous carbons. The results of the investigation show that the isotherm of water vapor adsorption on active carbons is characterized by a sigmoidal shape. The authors propose a new equation for the isotherm of water vapor adsorption on active carbons. The equation is based on the assumption that the adsorption of water vapor on active carbons is a two-stage process. In the first stage the water vapor molecules are adsorbed on the surface of the carbon particles. In the second stage the water vapor molecules are adsorbed in the pores of the carbon particles. The authors show that the proposed equation describes the experimental data for the isotherm of water vapor adsorption on active carbons with high accuracy. The authors also show that the proposed equation can be used to determine the surface area of active carbons from the experimental data for the isotherm of water vapor adsorption.

Institution: Academy of Sciences USSR, Institute of Physical Chemistry

Submitted: October 20, 1954

"APPROVED FOR RELEASE: 08/22/2000

CIA-RDP86-00513R000411320009-1

APPROVED FOR RELEASE: 08/22/2000

CIA-RDP86-00513R000411320009-1"

AID P - 1368

Subject : USSR/Chemistry

Card 1/1 Pub. 119 - 1/6

Author : Dubinin, M. M., (Moscow)

Title : Study of the porous structure of activated carbons by complex methods

Periodical : Usp. khim., 23, no. 1, 3-13, 1955

Abstract : Methods used for determining the three types of porosity are described: the impregnation of mercury or use of a microscope for macropores; the electron microscope for intermediate pores; adsorption of dissolved substances for micropores. Eight diagrams, 2 photos, 3 tables, 23 references (20 Russian: 1936-53).

Institution : None

Submitted : No date

AD P - 3166

Subject : USSR/Chemistry
Card 1/1 Pub. 119 - 1/8
Author : Dubinin, M. M. (Moscow)
Title : Surface oxides and adsorption capacity of activated carbon
Periodical : Usp. khim., 24, 5, 513-526, 1955
Abstract : A review of the literature on the adsorption of oxygen by activated carbons of varied origin is given. Chemical and physical adsorption as well as chemisorption of oxygen by carbon at various temperatures are discussed in detail. Ten diagrams, 1 table, 40 references, 22 Russian (1929-1955).
Institution : None
Submitted : No date

DUBININ, M.M., akademik.

Ways of developing chemical science in the sixth five-year plan.
Khim.nauka i prom. 1 no.2:122-124 '56. (MLRA 9:9)

(Chemistry)

DUBININ, M.M.; ZAVERINA, Ye.D.

Nature of the surface and sorptive properties of activated carbons.
Part 2. Study of the effect of chemical adsorption and chemisorption
of oxygen on the adsorptive properties of activated carbons with the
use of water vapors. Izv. AN SSSR. Otd.khim.nauk no.9:1038-1049
S '56. (MIRA 9:11)

1. Institut fizicheskoy khimii Akademii nauk SSSR.
(Carbon, Activated) (Oxygen)

DUBININ, M.M. (1)

USSR/Surface Phenomena. Adsorption. Chromatography. Ion Inter- B-13
change

Abs Jour : Ref Zhur - Khimiya, No 8, 1957, 26362

Author : M.M. Dubinin (I); M.M. Dubinin, Ye.G. Zhukovskaya (I and II).
Title : Study of Porous Structure of Solid Bodies by Sorption Methods.
I. Analysis of Various Methods of Computation of Pore Volume
Distribution. II. Comparison of Various Methods of Distribu-
tion Computation according to Volumetric Dimensions and Sur-
face of Pores of Sorbents with Typical Experimental Material.

Orig Pub : Zh. fiz. khimii, 1956, 30, No 7, 1652-1661; No 8, 1840-1851

Abstract : I. Various methods of computation of the distribution of the
volume and surface of pores in accordance to their dimensions
in case of porous sorbents were compared on the basis of ex-
perimental isotherms of vapor sorption. It is shown that the
methods based on the theory of capillary condensation (CC) and
on considering adjustments for vapor adsorption practically
differ very little one from another. The change in the sur-
face S_a of a cylindrical pore with the increase of the layer
thickness is not taken into consideration in the 1st variation
of Dubinin's method, and in the 2nd variation it is taken
into consideration approximately but simply; the adjustments
for the volume V_a and for l in the methods 1 and 2 are intro-

Card : 1/4

USSR/Surface Phenomena. Adsorption. Chromatography. Ion Inter-
change.

B-13

Abs Jour : Ref Zhur - Khimiya, No 8, 1957, 26362

duced on the basis of the experimental adsorption isotherm of the selected vapor on a non-porous adsorbent of the same chemical nature (quartz in case of silica gel, soot in case of active carbons, etc.); the point on the isotherm, at which the hysteresis starts, is accepted as the lower boundary of the applicability of the methods 1 and 2, which is physically justified, if the departure point was the CC theory. It is noted that the computations by the method of Barrett-Joiner-Halend, which is the most rigorous from the point of view of the assumed geometrical model of the sorbent, become very cumbersome, and a series of simplifications, which are not justified physically, are introduced to render the computation easier. The methods, in which 1 is assumed to be constant in the region of CC, are also discussed.

II. The distribution according to the dimensions of the volume and surface of pores was computed by the methods 1, 2, and 3 using bibliographical data about the sorption of N_2 at $78.1^\circ K$ on a relatively fine-porous aluminosilicate catalyst (ASC) (p / p_s 0.35 to 0.95) and the isotherms of C_6H_6 sorption

Card : 2/4

USSR/Surface Phenomena: Adsorption: Chromatography. Ion Inter-
change

B-13

Abs Jour : Ref Zhur - Khimiya, No 8, 1957, 26362

recorded by the authors at 20° on active carbon (AC) with a developed transition porosity (p / p_s 0.75 to 1.00). The adjustment for the adsorption of N_2 on ASC was computed using the computation tables of the method 3, and the adjustment for C_6H_6 adsorption on AC was computed using the adsorption isotherm of C_6H_6 at 20° on spenone-6 sooth. It is shown that the computation results by all the three methods are close, and that the results by the 2nd and 3rd methods are practically the same. Of all the approximate methods, in which l is assumed constant (and, according to Dubinin, corresponding to the value at the start of CC, but according to Olton, corresponding to the mean value of the CC region) or equal to zero in the limiting case, the Dubinin's method yields results which are the closest to the results obtained by rigorous methods. It is shown than among the rigorous methods, the most preferable is the 2nd. The conclusion is arrived at that the rigorous methods based of the CC theory should not be applied to silica gels and other sorbents

Card : 3/4

USSR/Surface Phenomena, Adsorption. Chromatography. Ion Inter-
change

B-13

Abs Jour : Ref Zhur - Khimiya, No 8, 1957, 26362

similar to them with a pore radius under 15 Å in consequence of the rise of adsorption potentials in fine pores ($\Delta \varphi$), and that in case of apolar AC-s, where $\Delta \varphi$ is still greater, these methods are applicable only to the computation of the distribution of transition pores; the approximate methods may be applied only at relatively uniformly porous sorbents and on condition that the constant thickness of the adsorption layer is selected for p / p_s answering the most probable efficiency radius of the sorbent pores.

Card : 4/4

25211

S/062/61/000/007/001/009
B117/B230

S 1115

AUTHOR:

Dubinin, M. M.

TITLE:

Examination of adsorption properties and of secondary porous structure of adsorbents having the effect of molecular screens

PERIODICAL:

Akademiya nauk SSSR. Izvestiya. Otdeleniye khimicheskikh nauk, no. 7, 1961, 1183-1191

TEXT: Communication 2. Confrontation of calculated and experimental extreme values of adsorption and of adsorption volumes for synthetic zeolites of the type A. In this work an attempt was made to calculate the extreme values of adsorption and adsorption volumes of completely dehydrated crystals in Na (NaA) and Ca form (CaA) on the basis of data supplied by the literature on X-ray structural analysis and on the chemical composition of crystalline unit cells of synthetic A type zeolites. The aim of the present study was to compare the calculated values with those obtained by experiments. To achieve this task, amply sufficient information

Card 1/13

25211

S/062/61/000/007/001/009
B117/B230

Examination of adsorption...

on X-ray structural analysis was contained in Refs. 5, 6, and 8 (Ref. 5: T. B. Reed, D. W. Breck, J. Amer. Chem. Soc. 78, 5972 (1956); Ref. 6: R. M. Barrer, W. M. Meier, Trans. Faraday Soc. 54, 1074 (1958); Ref. 8: L-Broussard, D. P. Schoemaker, J. Amer. Chem. Soc. 82, 1041 (1960). The main characteristics of the porous structure, the extreme values of adsorption and adsorption volumes, as well as some properties of dehydrated zeolite crystals were computed on the basis of data of Refs. 4 and 5 (Ref. 4: D. W. Breck, W. G. Eversole, R. M. Milton, T. B. Reed, T. L. Thomas, J. Amer. Chem. Soc. 78, 5963 (1956)) on the composition of unit cells of completely hydrated A-type zeolites in sodium and calcium form, as well as on the parameters of unit cells. Data used and results of calculations are collected in Table 1. It is concluded herefrom that experimental values of real density of hydrated zeolite crystals are on the average by 2.5 per cent higher than those of X-ray densities. Water content in completely hydrated zeolite crystals is by about 10 per cent higher with Ca form than with Na form. This is in relation to the higher hydrate water content and lower molecular weight of unit cells of CaA zeolites. The cavity volumes show a difference of about 12 per cent

Card 2/3

9/062/61/000/008/003/010
B117/B206

AUTHORS: Dubinin, M. M., Zaverina, Ye. D. (Deceased),
Luk'yachovich, V. M., and Kharlamov, N. P.

TITLE: Investigation of the adsorption properties and the
secondary pore structure of adsorbents having the effect
of microfilters. Communication 3. Components of grains
of synthetic A-type zeolites

PERIODICAL: Akademiya nauk SSSR. Izvestiya. Otdeleniye khimicheskikh
nauk, no. 8, 1961, 1380-1387

TEXT: In sorption technique synthetic zeolites are mainly used in the
form of grains, tablets, and balls. The main components of the grains are
crystalline zeolite powders and binding agents. In order to clarify the
properties of these components, the authors investigated the dispersity of
zeolite crystals and their adsorption properties as well as the share of
the binding agent in sorption. Crystalline specimens of A-type zeolites
were used, which were synthesized by some Soviet scientists: I. Ye. Neymark
(Nm), Ya. V. Mirskiy (Mr), L. M. Maksimova (Mk) and B. A. Lipkind (Lp).

Card 1/4

Investigation of the adsorption...

S/062/61/000/008/003/010
B117/B206

The designation of the specimens is composed of the abbreviated name of the scientist and the specimen number given by him. American commercial specimens in the form of crystalline zeolite powders of the types 4-A and 5-A by the firm of Linde were used for comparison. To the sodium form (NaA) belonged: HM-300 (Nm-300), Nm-347, Mp-275 (Mr-275), Mk-90 (Mk-90), Mk-1 experiment, ЛП-202-2 (Lp-202-2) and Linde 4-A. To the calcium form (CaA) belonged: Mr-276 and Linde 5-A. The specimens were photographed in an electron microscope of the type УЭМ-100 (UEM-100) with 800-fold magnification. Further magnification was achieved optically. The photographs made of different places of the preparations were statistically evaluated after magnification. Distribution curves of these crystals according to their size were plotted on the basis of these data. The zeolite specimens synthesized by Neymark and Mirskiy were found to be distinguished by relatively close distribution. Crystals of the size of 0.75μ are predominant in the preparations by Neymark and of the size of 1.2μ in those by Mirskiy. The zeolite specimens prepared by Maksimova and Lipkind are not only more coarsely disperse, but also have a wider distribution of the crystals. Benzene was used for investigating the adsorption properties. The adsorption isotherms were determined at 20°C

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Investigation of the adsorption...

S/062/61/000/008/003/010
B117/B206

follows: D. W. Breck, W. G. Eversole, R. M. Milton, T. B. Read,
T. L. Thomas, J. Amer. Chem. Soc. 78, 5963 (1956); T. B. Read, D. W. Breck,
J. Amer. Chem. Soc. 78, 5972 (1956); R. M. Barrer, W. M. Meier, Trans.
Faraday Soc. 54, 1072 (1958); L. Broussard, D. P. Shoemaker, J. Amer.
Chem. Soc. 82, 1041 (1960).

ASSOCIATION: Institut fizicheskoy khimii Akademii nauk SSSR (Institute
of Physical Chemistry, AS USSR)

SUBMITTED: December 12, 1960

Card 4/4

S/062/61/000/008/004/010
B117/B206

AUTHORS: Dubin, M. M., Vishnyakova, M. M., Zaverina, Ye. D.
(Deceased), Zhukovskaya, Ye. G., and Sarakhov. A. I.

TITLE: Investigation of the adsorption properties and secondary
pore structures of adsorbents having the effect of micro-
filters. Communication 4. Granulated synthetic zeolites
of the A-type

PERIODICAL: Akademiya nauk SSSR. Izvestiya. Otdeleniye Khimicheskikh
nauk, no. 8, 1961, 1387-1395

TEXT: The authors investigated the adsorption properties, the secondary
pore structures of the grains and their apparent and gravimetric density.
Granulated A-type zeolites obtained by Soviet scientists at the beginning
of studies in the field of zeolite synthesis, were investigated. A number
of specimens by Ya. V. Mirskiy (Mr) were used, during the production of
which the pressure was repeatedly changed, and one specimen by
B. A. Lipkind (Lp). The designation of the samples is composed of the
abbreviated name of the producer and the specimen number given by him

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S/062/61/000/008/004/010
B117/B2C6

Investigation of the adsorption...

Two specimens each of granulated zeolites by the American firm of Linde (I) and (II) in the form of grains with $1/8$ " diameter were used for comparison. To the sodium form (NaA) belonged: Mr-296, Lp-202-A, Linde 4A (I), Linde 4A (II). To the calcium form (CaA) belonged: Mr-297, Mr-347, Mr-372, Mr-380, Linde 5A (I) and Linde 5A (II). The isotherms of sorption and desorption of benzene vapors were determined by sorption scales in vacuum. The specific method for experiments with zeolites was previously described by M. M. Dubinin (Ref. 3: Izv. AN SSSR. Otd. khim. n., 1961, 750). The isotherms determined had generally the same character as those mentioned by the authors, Ye. A. Leont'yev and V. M. Luk'yanovich (Ref. 2: Izv. AN SSSR. Otd. khim. n., 1961, 396). Adsorption isotherms of water vapors were measured by sorption scales in vacuum for direct comparison of the adsorption properties of granulated, completely dehydrated zeolites. The secondary pore structure of the grains was investigated by pressing in mercury, and according to the sorption method. Mercury porometry makes it possible to determine the distribution of the pore volumina according to their effective radii in the range of $1 \cdot 10^6$ to $15 \cdot 25 \text{ \AA}$. From the isotherms of capillary condensation of vapors

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Investigation of the adsorption...

S/062/61/000/008/004/010
B117/B206

of substances, for which the pore structure of zeolite crystals (primary porosity) is inaccessible, sorption volumina or the summary pore volumina with effective radii below 100 Å might easily be found. From these data the total volume of the secondary pore structure may be calculated. In experiments with mercury, low- and high-pressure pore meters were used (Ref. 4: M. M. Dubinin, A. I. Sarakhov and G. A. Ryabikov, Zh. fiz. khimii 32, 1404, (1958); Ref. 5: M. M. Dubinin, M. M. Vishnyakova, Ye. G. Zhukovskaya, Ye. A. Leont'yev, V. M. Luk'yanovich, A. I. Sarakhov, Zh. fiz. khimii 34, 2019 (1960)). Zeolite grains which were in equilibrium with the air humidity were applied. The main characteristics of the secondary pore structure of zeolite grains are listed in Table 3. Table 4 contains information on the volume of the secondary pore structure. When applying zeolite grains in practice, it is not the adsorptive power of the unit of mass of the grains which is of vital importance, but the unit of volume of the grain layer. Therefore, the correlation must be established between adsorption properties as well as apparent density of the zeolite granules and the volume of their secondary pore structure. This problem may be solved if composition of zeolite grains and volume of the secondary pores are known from experimental data. The calculated and experimental

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characteristic features of A-type zeolite grains are compared with each other in Table 5. The values for the apparent grain density agree well in general. The deviations amount to a maximum of 3%. The calculated and experimental maximum adsorption volumes for water are similar for NaA grains. For most of the CaA grains of Soviet and American origin, the maximum adsorption volumes are below the values calculated from the crystal content. A part of the highly disperse zeolite crystals, i.e., in CaA grains, is obviously excluded from the adsorption process for yet unclarified reasons. The latter are being investigated at present. The comparison of the granulated A-type zeolites synthesized by Soviet scientists with corresponding American specimens showed that with respect to their adsorption properties they are only identical at the surface of secondary pores. This concerns the accessibility of the pore structure of the actual zeolite crystals for the adsorbable molecules, as well as the adsorption of bigger molecules. The zeolite grains investigated show strongly differential volumina of the secondary pore structure. That is the main reason for the fact that the apparent and gravimetric density and thus the adsorption properties of granulated zeolites are different for the units of volume of the grain layers. The authors thank B. A. Lipkind

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Investigation of the adsorption...

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and Ya. V. Mirskiy for supplying specimens and experimental data on apparent densities of the grains. There are 2 figures, 5 tables, and 7 references: 5 Soviet-bloc and 2 non-Soviet-bloc. The two references to English-language publications read as follows: D. W. Breck, W. G. Eversole, R. M. Milton, T. B. Read, T. L. Thomas, J. Amer. Chem. Soc. 78, 5963 (1956); R. M. Barrer, W. M. Meier, Trans. Faraday Soc. 54, 1072 (1958).

ASSOCIATION: Institut fizicheskoy khimii Akademii nauk SSSR (Institute... of Physical Chemistry, AS USSR)

SUBMITTED: December 12, 1960

Card 5/8

S/080/61/034/001/013/020
A057/A129

AUTHORS: Dubinin, M.M., Zaverina, Ye.D.

TITLE: Adsorption Properties and Microporous Structure of Industrial Active Carbons

PERIODICAL: Zhurnal Prikladnoy Khimii, 1961, Vol. 34, No. 1, pp. 113-120

TEXT: In the present paper an attempt was made to classify active carbons used as adsorbates. The "potential theory of adsorption", developed by the present authors [Ref.4: ZhFKh, 21,1351 (1947), Ref.5: ZhFKh, 23,1129 (1949), Ref.6: Izv. AN SSSR, OKhN, 1165 (1958), Ref.7: Izv. AN SSSR, OKhN, 981 (1959), Ref.8: Izv. AN SSSR, OKhN, 7,1153 (1960)], is discussed and active carbons were divided into three groups: 1. Gas-retort carbons used for adsorption of gases and vapors of high-boiling substances; 2. recuperative carbons provided for adsorption and recovery of vapors of solvents; 3. decoloring carbons for separation of substances from solutions and decoloration of solutions and liquids. The potential theory of adsorption correlates the microporous structure of active carbons with their adsorption characteristics. Hence these

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S/080/61/034/001/013/020
A057/A129

Adsorption Properties and Microporous Structure of Industrial Active Carbons

adsorbates can be classified by the different types of structure. Active carbons with small micropores have the greatest adsorption capacity and represent the first type of structure. For these adsorption a (in millimole per gram) is calculated at a definite temperature T and in equilibrium pressures p/p_s by the following equations:

1. for vapors at $T < T_{crit.}$ $\log a = C - D (\log p_s/p)^2$ (1)
where $C = \log W_0/v^*$ [Abstracter's note: error, in original paper S^* instead of v^*]

and $D = 0.434 \cdot B \cdot T_2/\beta^2$; (3)

2. for gases at $T > T_{crit.}$ $\log a = C - D (\log \tau^2 p_{crit.}/p)^2$ (4)
where $C = \log W_0/b$ and $\tau = T/T_{crit.}$ (6)

These equations contain two structural constants, i.e., W_0 = boundary volume of adsorption space (i.e. total volume of micropores) and B = constant, depending on the size of micropores; v^* = volume of 1 millimole of adsorbed vapor, b = Van der Waals constant, β = coefficient of affinity of characteristic curves (approximately expressed by $\beta = \frac{P}{P_0}$) (7). P = parachor of the investigat-

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Adsorption Properties and Microporous Structure of Industrial Active Carbons

ed and P_0 of standard adsorbed substance). W_0 and B were determined by the adsorption isotherm of the adsorbed standard substance ($\beta = 1$). The values of P_g , $P_{crit.}$, v^* and v can be taken from tables. The second type of structure is represented by active carbons with only great micropores and no effect of an increasing adsorption potential is to be observed. Equations for the adsorption of vapors

($T < T_{crit.}$) are given by: $\log a = M - N \log p_g/p$ (8) .

where $M = \log W'_0/v^*$, (9) $N = 0.434 A T/\beta$ (10)

Equation (8) contains two structural constants W'_0 - boundary volume of adsorption space and the constant A with an approximate value $4 \cdot 10^{-3}$ if the carbon does not have many small micropores. Active carbons with small micropores and greater micropores belong to the mixed structural type. This adsorption theory yields a scientific explanation of the above-mentioned classification and also a determination of a certain number of carbon samples within each structural type for specific uses in industry. Based on a generalization of investigations of many years into active carbon samples used in

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laboratory and industry in the present paper, carbons produced in the USSR and abroad are classified according to their use. Using the vacuum method, evacuation of carbon samples occurred at 450°C to a residual pressure of $1 \cdot 10^{-6}$ torr and then the adsorption characteristics were determined for adsorbing benzene vapor ($\beta = 1$) at 20°C. Constants of the adsorption isotherm equations and characteristics of investigated carbons are presented in Tab.1-4. Industrial active carbons of the gas-coal type generally belong to the first structural type. Only AG and Au-32 types belong to the mixed structural type and their adsorption properties are not characteristic for the gas-coal type. Adsorption occurs in carbons of the first structural type in a volume limited by the partitions of the micropores. For the investigated samples of this type the volume of micropores is 0.22-0.62 cm³/g. Micropores with a volume above 0.4 cm³/g are characteristic for carbons used in chemical activations. Increase in volume of micropores effects a change in adsorption properties, but the latter are more affected by a change in the constant B, especially adsorption properties of gases and vapors of highly volatile substances. Industrial recuperation carbons belong generally to the mixed structural type,

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while decoloring carbons all belong to the second structural type. There are 4 tables and 12 Soviet references.

ASSOCIATION: Institut fizicheskoy khimii AN SSSR (Institute of Physical Chemistry of the AS USSR)

SUBMITTED: July 4, 1960

Card 5/14
5

35386

S/080/61/037/002/005/025

A051/A:29

5.1115

AUTHOR: Dubinin, M.M.

TITLE: On rational types of industrial active carbons intended for use as adsorbents

PERIODICAL: Zhurnal Prikladnoy Khimii, v 34, no 2, 1961, 291-299

TEXT: According to "the potential theory" of physical adsorption of gases and vapors developed by the present author and in continuation of previous works (Ref. in ZbPKh, 34, 1, 113 (1961)), active carbons used as adsorbents were classified in the present paper. Structural types of adsorbents with energetically heterogeneous surface were discussed, and a suitable number of groups or sorts of active carbons were specified with their structural and adsorption characteristics within the limits of three principal types of industrial active carbons, i.e., gas G (2), recuperation P (R), and decolorizing O (D) carbons. Adsorption equations for the ad-

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On rational types of industrial active carbons.

sorption of gases and vapors presented in Ref 1 can be expressed by $a = a_0 F$ (where $a_0 = W_0 / V$, and a_0 - limited amount of adsorbed gas or vapor, W_0 (or W_0^0) - limited volume of adsorption space, V (or b) - mean volume of adsorbed substance in millimole). F represents the respective value of adsorption at given experimental conditions (p , T) and is called by the present author "the adsorbability factor". The practical value of active carbons is determined not only by equilibrium characteristics, but also by kinetic properties. Adsorption kinetics is controlled by the diffusion transfer of the adsorbed substances to the micropores by "transport pores", i.e., macro- and transition pores. According to investigations by the present author the diffusion transfer towards micropores is completely secured with macropore volumes of 0.15-0.20 cm³/g and transition-pore volumes of 0.05 cm³/g. The value a_0 does not depend noticeably on changes in W_0 . Much greater effect on adsorption properties of active carbons has a change of the constants B and A discussed in the previous paper (Ref 1). The present classification of active carbons as adsorbents is based on investigations of the adsorbability factors F . In order to demonstrate results of theoretical analyses, the factor F was calculated for 20° and

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100°C at $p = \text{const.}$ for ethylene, tetrafluoroethylene and benzene, i.e., substances with a very different adsorbability on active carbons. The effect of decrease in adsorbability was characterized by the factor $\Gamma = F(p, 100^\circ\text{C})/F(p, 20^\circ\text{C})$ and according to desorption characteristic and equilibrium pressure p by $\alpha = F(0.1 p, 100^\circ\text{C})/F(p, 20^\circ\text{C})$. Results (Tab 2) obtained for G-type carbons demonstrate the strong effect of the change of the structural constant B on adsorbability already observed (Ref 1). Increase in B by 3 times decreases ethylene adsorbability ($p, 20^\circ\text{C}$) about 15 times, and tetrafluoroethylene adsorbability by almost 5 times. The difference in adsorbability of these two substances increases with temperature. Carbons of the G-type must belong to adsorbents of the first structural type and could be classified in the following 4 groups according to a value of $B \cdot 10^6$ (using benzene as standard): $\Gamma - 1(G-1)$ 0.40-0.55, $\Gamma - 2(G-2)$ 0.55-0.70, $\Gamma - 3(G-3)$ 0.70-0.95, $\Gamma - 4(G-4)$ 0.95-1.0. Since these carbons are used in installations with fluidized beds they must have a high grinding resistance. In investigations of active recuperation carbons adsorption and desorption capacity was considered, since repeated

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adsorption-desorption cycles were carried out with these carbons in practice. Results obtained for R-type carbons demonstrate (Tab. 3) that in active carbons of the first structural type P does not change noticeably with B at room temperature, thus adsorption is determined principally by A . In active carbons of the second structural type a considerable effect of changes in the constant A on adsorbability is to be observed, especially at higher temperatures. For the first structural type desorption occurs favorably at $B \gg 1 \cdot 10^{-6}$, and especially for second structural type carbons at $A \gg 2 \cdot 10^{-3}$. On the other hand all carbons of the R-type group belong to the mixed structural type (see Ref 1). According to Table 3 the present author considers only two groups of R-type carbons as suitable: $P-1(R-1)$ isotherm of the first structural type at $B \cdot 10^6 \gg 1$, and $P-2(R-2)$ isotherm of the second structural type at $A \cdot 10^3 \approx 2-3$ and applicability of the equation for the adsorption on adsorbents of the second structural type (see Ref 1) to a wide interval of p/p_s . Methods for the manufacture of R-type carbons with $A \cdot 10^3 \gg 3$ should be developed and thus group $P-3(R-3)$ should be obtained. Active carbons of the D-type can be classified on the basis of R- and G-type carbons, since for the adsorption of substances with

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small molecular weights active carbons of the first structural type (not too small B values) can be used. For adsorption of high molecular and colloidal impurities (dyes etc.) active carbons of the second structural type are suitable. Thus for the first structural type group OI-1(DI-1) corresponding to R-3(G-3), OI-2(DI-2) corresponding to R-4(G-4), and for the second structural type OII-1(DII-1) corresponding to P-2(R-2), OII-2(DII-2) corresponding to P-3(R-3) are considered suitable by the present author. Since for the adsorption from liquids not only the structure, but also the nature of the surface of the adsorbent is important, the group of D-type carbons should contain active carbons obtained by different methods (for example oxidized carbons with acid oxides on the surface). There are 3 tables and 8 Soviet-bloc references.

SUBMITTED: July 4, 1960

Card 5/5.

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24.7100

24056
S/O20/61/138/004/017/023
B103/B203

AUTHOR: Dubinina, M. M., Academician

TITLE: Composition of elementary cells and limit adsorption volumes of dehydrated crystals of synthetic zeolites

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 138, no. 4, 1961, 866-869

TEXT: On the basis of the shape and size (known from X-ray structural data) of the elementary cell of dehydrated crystals of synthetic zeolites of the A type it is easily possible to calculate the total volume of the cell and the limit adsorption volume of one unit of mass of such crystals which are accessible to molecules of different sizes. For zeolites of the X type this problem is solved with difficulty since here the centers of the cubic-octahedral units lie at the nodes of the diamond-like crystal lattice. Thus, the cages in the elementary cell are asymmetrically distributed. The author attempts to solve this problem by calculating the apparent volume of the cubic-octahedral unit on the basis of X-ray structural data of the elementary cell of A zeolite of the volumes of the four- and six-membered oxygen bridges in the aluminum silicate framework

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24056

S/020/61/138/004/017/023

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Composition of elementary cells and ...

of the cells of A and X zeolites. According to the model of this framework of Na zeolite (Ref. 2: R. M. Barrer, W. M. Meier, Trans. Farad. Soc., 54, 1074 (1958)), one elementary cell of the crystal contains one cubic-octahedral structural unit and three corresponding four-membered oxygen bridges. On the other hand, one cell contains one practically spherical "super-cage" with a diameter of 11.4 Å and a volume of 776 Å³, further one small cage inside the cubic octahedron (diameter 6.6 Å, volume 150 Å³). If a_0 is the parameter of the elementary cell of NaA, then the apparent volume of the cubic-octahedral unit $V_{co} = a_0^3 - (776 + 3V_{4br})$ (8), where V_{4br} is the volume of a four-membered oxygen bridge. The author constructs the model of such a bridge which connects (by way of oxygen ions) the (Al, Si) ions lying at the endpoints of the four-membered windows of adjacent cubic-octahedral units. For the radius of the circumference of a normal section in the middle of the bridge he calculates the value 3.7 Å. If this bridge represents a cylinder with the said radius and a diameter of 2.8 Å (diameter of the oxygen ion), then its volume is 116 Å³. On the basis of (8), the apparent volume of the cubic-octahedral unit will be 724 Å³ for $a_0 = 12.273 \pm 0.003$ Å (Ref. 2), i.e. for a volume of the

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Composition of elementary cells and ...

elementary cell of $1848 \text{ \AA}^3$. One elementary cell of NaX zeolite with $a_c = 24.94 \text{ \AA}$ (Ref. 4: R. M. Barrer, F. W. Bultitude, J. W. Sutherland, Trans. Farad. Soc., 53, 1111 (1957)) and a volume of $15513 \text{ \AA}^3$ contains eight cubic-octahedral units with 16 connecting oxygen bridges. If V_{6br} is the volume of such a bridge, then the total volume of eight "super-cages" $V_s = 15513 - 8 \cdot 724 - 16V_{6br}$ (9) in one elementary cell. On the basis of a model constructed similarly to that of NaA zeolite, the author calculates $V_s = 6490 \text{ \AA}^3$. Only the volume of these cages is accessible to most molecules of the substances adsorbed such as nitrogen, hydrocarbons, etc. Besides the "super-cages", the internal or small cages of the cubic octahedra are also accessible to water molecules through the "windows" (volume per cubic octahedron, $150 \text{ \AA}^3$). Their total volume in one cell of NaX zeolite, $V_{sm} = 150 \cdot 8 = 1200 \text{ \AA}^3$. The total volume of all cages accessible to water molecules is $V = V_s + V_{sm} = 6490 + 1200 = 7690 \text{ \AA}^3$ (10). The limit adsorption volume of $7670 \text{ \AA}^3$ practically corresponds to the number of water molecules (256) which, according to Ref. 4, is contained

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Composition of elementary cells and ...

in one elementary cell of fully hydrated NaX zeolite. In the introduction, the author discusses use, production, and chemical composition of A and X zeolites. He calculates the molar ratio $\text{SiO}_2/\text{Al}_2\text{O}_3$ (x), while the number n brings the content of atoms (ions) of Na, Al, Si, and O in the framework of the elementary cell into agreement with X-ray structural data. Thus, $n = 192/(2+x)$ (6) for NaX zeolite, while the analogous formula for NaA zeolite is: $n = 24/(2+x)$. The cubic-octahedral unit of A zeolite contains 12Al^{3+} , 12Si^{4+} , and 36O^{2-} , whereas that of X zeolite contains 10Al^{3+} , 14Si^{4+} , and 36O^{2-} . 12O^{2-} each belong to the oxygen bridges in A and X zeolite. The excess negative charges of the cubic-octahedral units and the corresponding oxygen bridges are compensated by Na^+ , whereby their number in the zeolite is also determined. The author thanks N. A. Shishakov for a discussion of the results obtained. There are 1 table and 4 non-Soviet-bloc references. 2 references to English-language publications are mentioned above, the third reads as follows: Ref. 3: L. Broussard, D. P. Shoemaker, J. Am. Chem. Soc., 82, 1041 (1960).

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Composition of elementary cells and ...

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B103/B203

ASSOCIATION: Institut fizicheskoy khimii Akademii nauk SSSR (Institute
of Physical Chemistry of the Academy of Sciences USSR)

SUBMITTED: March 8, 1961

Card 5/5

BERING, B.P.; DUBININ, M.M., akademik; SERPINSKIY, V.V.

Adsorption isosters in the potential theory. Dokl. AN SSSR 138
no.6:1373-1376 Je '61. (MIRA 14:6)

1. Institut fizicheskoy khimii AN SSSR.
(Adsorption) (Potential, Theory of)

DUBININ, M.M., akademik, otv. red.; SERPINSKIY, V.V., doktor khim.
nauk; ZHUKOVSKAYA, Ye.G., red.; GOLUB', S.P., tekhn. red.

[Synthetic zeolites; preparation, investigation, and uses]
Sinteticheskie tseolity; poluchenie, issledovanie i pri-
menenie. Moskva, Izd-vo Akad. nauk SSSR, 1962. 286 p.
(MIRA 15:10)

1. Akademiya nauk SSSR. Otdeleniye khimicheskikh nauk.
Komissiya po tseolitam.

(Zeolites)

S/062/62/000/006/001/008
B117/B101

AUTHORS: Dubinin, M. M., Zhukovskaya, Ye. G., and Murdmaa, K. O.

TITLE: Study of adsorption properties and secondary pore structure of adsorbents with molecular screen effect. Communication 6. Adsorption of nitrogen and water vapors on X-type zeolites, and the potential theory of adsorption

PERIODICAL: Akademiya nauk SSSR. Izvestiya. Otdeleniye khimicheskikh nauk, no. 6, 1962, 960 - 968

TEXT: *Adsorption isotherms of nitrogen vapor (at -195°C) and water vapor (at 20°C) on dehydrated X type zeolites, in sodium and calcium form, were studied at $1 \cdot 10^{-3} - 5 \cdot 10^{-1}$ mm Hg. Discussion of the results is based of author's potential theory (Zh. fiz. khimii, 21, 1351 (1947); ibid. 23, 1129 (1949); Chem. Revs. 60, 235 (1960)). Results: (1) The X type zeolites belong to the first structural type (Dokl. AN SSSR, 131, 865 (1960)). Therefore, the equation for the adsorption isotherm developed for finely porous carbon adsorbents applies to it. (2) The limit volumes of the adsorption space practically correspond to the hollow space volumes of the
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Study of adsorption properties ...

S/062/62/000/006/001/008
B117/B101

zeolites as calculated on the basis of the X-ray structural analysis; according to the potential theory they are, therefore, one of the main characteristics of the structure of the adsorbent. (3) The millimole volumes (cm^3/mmole) of the adsorbed substances coincide well with the millimole volumes of its liquid phases. This supports the assumption that substances in the adsorbed state have the same density as in the liquid phase. (4) In case of water adsorption on X type zeolites electrostatic forces assist in increasing the affinity coefficient β to 1.65 ($\beta = 0.76$ for the nitrogen standard). There are 4 figures and 3 tables.

ASSOCIATION: Institut fizicheskoy khimii Akademii nauk SSSR (Institute of Physical Chemistry of the Academy of Sciences USSR)

SUBMITTED: December 27, 1961

Card 2/2

S/062/62/000/012/001/007
B101/B186

AUTHORS: Dubinin, M. M., Zhukovskaya, Ye. G., Murdman, K. O., and
Polstyanov, Ye. F.

TITLE: Study on adsorption properties and secondary pore structures
of adsorbents with a molecular sieve effect. Communication
VII. Volumes of the cavities of dehydrated crystals of
synthetic A and X zeolites, which are filled by vapor
adsorption of various substances

PERIODICAL: Akademiya nauk SSSR. Izvestiya. Otdeleniye khimicheskikh
nauk, no. 12, 1962, 2113-2121

TEXT: The isothermal lines of the sorption of water at 20°C, nitrogen at
-195°C, and benzene at 20°C were plotted for NaA, CaA, NaX, and CaX
zeolites to determine the characteristic adsorption values. The adsorption
volumes were determined: (1) by calculation from the isothermal equation
(Izv. AN SSSR, Otd. khim. n., 1958, 1165), developed on the basis of the
potential theory of adsorption; (2) by determining graphically the
characteristic equilibrium pressure p_0 for each vapor before capillary
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Study on adsorption properties and ...

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condensation sets in. The values (v^0) obtained in two different ways were consistent (in cm^3/g): with H_2O at 20°C 0.269 - 0.272 for NaA, 0.279-0.283 for CaA, 0.323 - 0.338 for NaX, 0.355 - 0.360 for CaX; with N_2 at -195°C 0.287 for CaA, 0.336 - 0.340 for NaX, 0.349 - 0.350 for CaX, and with C_6H_6 at 20°C 0.293 - 0.297 for NaX, and 0.300 - 0.301 for CaX.

Calculation of the number n of unit cells with the composition $z[y\text{Na}_2\text{O} \cdot (1-y)\text{H}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot x\text{SiO}_2]$ and the molecular weight M per unit weight of the zeolite crystal gave: for NaA: $x = 2.06$, $y = 0.93$, $z = 5.91$, $M = 1683$, $n \cdot 10^{-20}/\text{g} = 3.58$; for CaA: $x = 2.06$, $y = 0.93$, $z = 5.91$, $M = 1654$, $n \cdot 10^{-20}/\text{g} = 3.64$; for NaX: $x = 2.96$, $y = 0.964$, $z = 38.71$, $M = 13171$, $n \cdot 10^{-20}/\text{g} = 0.457$; for CaX: $x = 2.96$, $y = 0.964$, $z = 38.71$, $M = 12950$, $n \cdot 10^{-20}/\text{g} = 0.465$. The volume of the cavities filled during maximum adsorption, calculated from $v_c = v^0/n$, has the following values:

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(in $\text{\AA}^3$) with H_2O : 756 for NaA, 772 for CaA, 7221 for NaX, 7688 for CaX;
with N_2 : 788 for CaA, 7396 for NaX, 7516 for CaX; and with C_6H_6 : 6455
for NaX, 6462 for CaX. The cavity volume per structural unit, is
obtained by dividing the v_0 values by the number q of cubooctahedrons per
unit cell ($q = 1$ for A zeolites, $q = 8$ for X zeolites). For A zeolites
it is $772 \text{\AA}^3$, and for X zeolites $932 \text{\AA}^3$. There are 6 figures and 6
tables.

ASSOCIATION: Institut fizicheskoy khimii Akademii nauk SSSR
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SUBMITTED: April 13, 1962

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DUBININ, M.M., akademik

Important aspects of the exchange of scientific information. Vest.
AN SSSR 32 no.4:40-43 Ap '62. (MIRA 15:5)
(Science—Information services)

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AUTHORS: Dubinin, M. M., and Zhukovskaya, Ye. G.

TITLE: Konstantin Vasil'yevich Chmutov. On the occasion of his
60th birthday

PERIODICAL: Zhurnal fizicheskoy khimii, v..36, no. 4, 1962, 923 - 924

TEXT: K. V. Chmutov was 60 years old on March 21, 1962. He was born in Moscow and started his career in Bezhitsa at the zavod Krasnyy Profintern (Krasnyy Profintern Plant). In 1926, as a student of the Moskovskoye vyssheye tekhnicheskoy uchilishche (Moscow School of Higher Technical Education) K. V. Chmutov got interested in surface phenomena. Professor N. A. Shilov asked Chmutov to participate in his studies. K. V. Chmutov was teaching at the Moscow School of Higher Technical Education for more than 25 years. In 1940 he submitted a dissertation "Sorbtionnyye yavleniya v kapillyarnykh sistemakh" (Sorption phenomena in capillary systems) for a doctor's degree. After a short time he became a professor. Jointly with M. M. Dubinin, he wrote the book "Fiziko-khimicheskiye

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Konstantin Vasil'yevich Chmutov. On ...

osnovy protivogazovogo dela" (Physico-chemical fundamentals of gas defense). From 1943 to 1950 he was Head of the Kafedra kolloidnoy khimii (Department of the Chemistry of Colloids). He studied the diffusion kinetics, the temperature dependence of the diffusion coefficient in the system polymer-monomer and the growth of vanadium pentoxide particles. At the Institut fizicheskoy khimii AN SSSR (Institute of Physical Chemistry of AS USSR), a laboratoriya khromatografii (Laboratory for Chromatography) was established at the end of the forties and K. V. Chmutov was put in charge of it, as well as of the Komissiya po khromatografii (Commission for Chromatography) at the Otdeleniye khimicheskikh nauk AN SSSR (Department of Chemical Sciences AS USSR). In this laboratory, physico-chemical properties of the ion exchange of sorbents are studied, chromatographic processes simulated, and the requirements for producing chromatograms of nonequilibrium working conditions of the ion exchange column are investigated. In the field of producing spectrally pure salts, a new adsorption complex-forming method for the separation of metals may be introduced. The following monographs were published by K. V. Chmutov: "Tekhnika fiziko-khimicheskogo eksperimenta" (Technique of the Physico-chemical experiment), (3rd edition 1954);

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